Stock Enhancement in the Murray-Darling Basin, Identification of Stocked Fish and Enhancing Post-stock Survival

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Thesis submitted for the degree of Doctor of Philosophy

June 2011

Table of Contents **Page**

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Acknowledgements

This work was supported by the Murray-Darling Basin Authority's Native Fish Strategy (Project MD741), The University of Adelaide, the Department of Industry and Investment New South Wales and the Department of Sustainability and Environment, Victoria.

Thank you to my supervisors, Bronwyn Gillanders, Andrew Munro and David Crook for comments, feedback, guidance and continued support throughout this period.

I would like to thank the staff from Adelaide Microscopy, University of Adelaide; in particular Angus Netting, Ben Wade and Aoife McFadden for assistance with both the laser ablation and solution inductively coupled plasma-mass spectrometers. I would also like to thank the staff from the Narrandera Fisheries Centre, especially Stephen Thurstan and Matthew McLellan, as well as staff from the Port Stephens hatchery. I also thank the Narrandera caravan park for providing long-term accommodation and to my sister Kayla and her partner for being in the right place at the right time with a spare bed on two different inter-state hatchery visits and for their patience when things did not always go to plan.

To all those who got me through the crazy times, and helped me out in the laboratory, aquarium room and with editing, thank you, particularly Laura Falkenberg and Rob Heart. To Flower and Tony, thank you for your understanding that a part time job is simply that and allowing me to never worry about placing my study first. To Mum, Dad and the extended family at large, for never doubting I could achieve whatever I set out to do. Your continued support has allowed me to get a far as I have. Thank you.

Abstract

Freshwater systems are experiencing a higher rate of decline in biodiversity compared with marine and terrestrial systems due primarily to water pollution, habitat degradation, species invasion, flow modification and over-exploitation. Stock enhancement programs to increase numbers of fish in these systems occur worldwide, however the success of these programs can be difficult to determine due to poor monitoring and the inability to distinguish between hatchery-stocked fish and wild recruitment. Severe declines in native fish distribution and abundance have occurred in the Murray-Darling Basin (MDB). Consequently, stock enhancement programs that stock millions of native fish annually have been established across the MDB to restore populations and provide recreational fishing opportunities. The success of these enhancement programs, however, is generally quantified solely in terms of the number of fish entering a system, not on the number surviving to reach reproductive age or enter the fishery. A method of marking stocked fish to determine post-release survival is required to assess the success of hatchery-reared fish after stocking into the MDB.

Native fish are not routinely marked before being stocked into the MDB, which makes it difficult to determine the percentage of fish in various populations comprised of stocked fish versus natural recruitment. A method that can be used to batch mark fish may be developed with the use of otolith (the ear bone of fish) chemistry, and an understanding of elemental incorporation. Using enriched stable isotopes, unique isotope signatures can be created into the calcifying structure of an otolith, leaving behind a permanent mark in stocked fish. I investigated whether larval otoliths of two native fish species, golden perch and Murray cod, could be marked with enriched stable isotopes. Each species has a different life history, and therefore the hatchery rearing of

larvae is different. Using a range of enriched stable isotopes from three elements, barium (Ba), strontium (Sr) and magnesium (Mg), singularly and in combination I explored the range of isotopic signatures that could be created. Unique signatures were created using stable isotopes of Ba and Sr; isotopes from these two elements had a high mark success rate and could be clearly distinguished from marks created with similar isotope combinations. Magnesium isotopes, however, were found to be poor markers with a low mark success compared to Ba and Sr stable isotopes.

Due to a lack of mark success with stable isotopes of Mg in comparison to stable isotopes of Ba and Sr, a trial was carried out on silver perch to determine the primary source of otolith Mg, to determine specifically if Mg in otoliths was sourced primarily from the water or diet. For this experiment, both the rearing water and diet were supplemented with increasing concentrations of Mg and the diet was spiked with an enriched Mg isotope. The experiment found that Mg was highly regulated in fish, although the majority of otolith Mg was sourced from the water.

Hatchery reared stocked fish are often predator naive, having never been exposed to a predator prior to release, this risk, combined with adjusting to a new environment results in low survival rates of stocked fish over the first few days after stocking. Exposing hatchery fish to chemical stimuli can increase predator awareness and possibly improve survival rates. To assess this behaviour, golden perch were exposed to a predator odour and alarm stimuli, and their post-stock behaviour in the presence of a potential predator was monitored. In addition, the presence and absence of habitat structure was also analysed to determine if it would influence the behaviour of golden perch. Habitat structure was found to increase the hiding time for all treatments. The exposure to predator odours had no influence on the behaviour of golden perch, and only influenced the time spent within a portion of the tank for one position. This

experiment indicated that choice of stocking site would contribute more to increasing post-stock survival of hatchery-reared golden perch rather than pre-stock predator training.

Enriched stable isotope marking was an effective method of mass marking different species of fish, with the methodology fitting within hatchery operating practices. This method of marking is not only applicable to fish stocking programs for the MDB, but can be applied to other stocking programs and hatcheries worldwide. Routine marking of stocked fish will enable fish monitoring programs to accurately assess how stocked fish are interacting within stocked systems. Research addressing the behaviour of stocked fish needs to identify and understand additional influential factors affecting survivorship of stocked fish. This research has developed a method for marking hatchery-produced fish, which can be used to evaluate fish stocking programs as well as providing some understanding of the differences in elemental incorporation into otoliths. Investigation into enhancing early survival of hatchery-stocked fish has found stocking density and appropriate habitat to be key in the early behavioural patterns of stocked fish.